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Title: Baking or Like Oven Steam Treatment Apparatus

The present invention relates to baking or like oven steam treatment apparatus for the provision of steam treatment in baking or like ovens. By "baking ovens" are meant ovens for the cooking of foodstuffs including, but not limited to, bread and related products. The invention is thus of particular applicability in the manufacture of bread and other "bakery" products (cakes, biscuits etc) but can also be useful in the cooking of other types of foodstuff such as meat products.

The use of steam as a means of generating a moist layer on the upper surface of baked goods is well known. This process is essential in a number of baking operations, an example of which is the gelatinisation of starch to create a good quality gloss and crust structure on bread and biscuit products.

Traditional methods of providing steam in a baking oven use a separate boiler, the steam from which is then injected into the oven cavity or chamber. However, this system is highly inefficient, substantial losses being experienced both in generating the steam and in transferring the steam via pipework to the oven which is often some distance away. Furthermore, the steam introduced into the oven is subsequently vented to the atmosphere - immediately in the case of continuous ovens and within 3 to 5 minutes in batch ovens. In addition there are a number of safety as well as capital cost disadvantages.

Recent developments in control have made it possible, in batch ovens, to directly inject fine particles of water, which instantly vaporise using the latent heat within the oven environment. However, using the latent heat within the oven in this way may not be suitable for all types of ovens, as it can drastically reduce the temperature within the environment and may result in an insufficient quality of gloss and crust structure being formed.

Although the approach of injecting fine particles of water into the oven offers cost benefits in terms of reduced capital cost and reduced fuel consumption, such systems are still inefficient as the steam generated is subsequently vented to atmosphere within 3 to 5 minutes.

- 5 The object of this invention is to provide improved steam treatment apparatus for or in baking or like ovens which overcomes or substantially mitigates the above mentioned and other disadvantages of the prior art.

According to the invention, steam treatment apparatus for the provision of steam in the baking or cooking cavity or chamber of a baking or like oven for the steam treatment of
10 foodstuff therein is characterised by the steam treatment apparatus providing a steam circulation pathway arrangement for or in communication with the cavity or chamber of a said oven whereby the cavity or chamber forms part of the circulation pathway arrangement for the circulation of steam therethrough, the apparatus further including means for generating steam for circulation along the pathway arrangement and means for causing the
15 steam to circulate along said pathway arrangement.

By 'pathway arrangement' is meant any suitable pipework, conduit, ducting or the like for the circulation of steam.

The apparatus according to the invention is advantageous for a number of reasons. First, it can be used to create an atmosphere of suitable characteristics (in terms of temperature,
20 humidity etc) for the particular product in the oven. The characteristics of the atmosphere can be closely controlled and maintained or changed as appropriate. The apparatus is also more efficient than known steaming systems in that the steam is provided or generated within the circulation pathway and hence energy losses during transmission of the steam are minimised. Existing energy sources, such as exhaust gases from the oven, can be used in the
25 generation of the steam, leading to further efficiencies, and the extent to which the steam is vented to the surrounding atmosphere is also minimised.

The steam circulation pathway, and the apparatus for generating steam and for causing the steam to circulate, can be integrated into the structure of the oven. Alternatively, separate apparatus can be provided which is connected to the oven cavity by suitable flow and return conduits or ducts such that the ducts constitute, together with the oven cavity, the steam circulation pathway. In such a case, the separate apparatus can incorporate the means for generating steam, the means for causing the steam to circulate, and also all necessary sensing and control functionality.

Thus, according to a second aspect of the invention, there is provided apparatus for the provision of steam in a baking oven, said apparatus comprising flow and return ducts adapted for connection in use to the baking oven so as to form a closed loop steam circulation pathway, means being included for providing steam for or within said pathway, and also means for causing the steam to circulate along said pathway.

The apparatus for providing steam in the steam circulation pathway may preferably include one or more nozzles by which steam or, more preferably, liquid water can be injected into the pathway. In the preferred case in which liquid water is injected, the water may be pre-heated and/or pressurised to an elevated temperature and pressure. In some applications, for instance, the water may be pressurised to a pressure of 15-20 bar, and heated to a temperature of 150-200°C. Heating of the water prior to injection into the steam circulation pathway can be brought about wholly or partly using existing energy sources, eg by the water being passed through a heat exchanger fed with hot exhaust gases from the oven heating system.

The nozzles through which steam, or more preferably water, is injected into the steam circulation pathway are preferably controllable to permit a variable rate of injection. In one embodiment, the or each nozzle is provided with a plurality of discrete outlets, the number of such outlets which are connected to the supply of water being variable.

The steam circulation pathway will be heated, at least partly, by virtue of the fact that the oven cavity forms part of the pathway. In addition, particularly where part of the circulation pathway is more remote from the oven cavity, eg where separate apparatus of the type described above is used, an auxiliary heater can be provided within the circulation pathway.

- 5 The means for causing circulation of steam within the steam circulation pathway most preferably comprises a fan or the like mounted within the steam circulation pathway or otherwise arranged to cause the circulation.

The rate at which steam is circulated within the steam circulation pathway may vary considerably, depending on the size and nature of the oven. However, typically, the steam
10 atmosphere within the circulation pathway is circulated at a flow rate of 0.3-0.4m³/s.

Where steam circulating within the steam circulation pathway enters the oven cavity suitable means can be provided to ensure that the steam is distributed appropriately within the oven cavity. Such means may take the form of deflectors, baffles or the like, positioned to deflect the circulating steam atmosphere in the desired directions. Alternatively, the steam can enter
15 the oven cavity via an apertured distribution plate or box, the openings in which are formed in such a way as to distribute the steam within the oven cavity in the desired manner.

The atmospheric conditions within the steam circulation pathway, ie the temperature and humidity, can be critical for satisfactory baking of foodstuff products within the oven cavity. For example, the temperature and humidity are the most important factors affecting
20 gelatinisation on the surface of bread and biscuit products to create a good quality glossy crust. Similarly, control of humidity can be important to prevent excessive weight loss in the cooking of meat products and the like. Suitable sensors are therefore preferably provided in the steam circulation pathway to facilitate measurement and control of the atmospheric conditions. In one preferred embodiment, the dew point is measured by means of a
25 capacitive hygrometer. Measurements of dew point can be related to the vapour pressure

which, in general, needs to be above a critical level to prevent or minimise unwanted evaporation of water from the products being baked. Typically, the temperature within the steam circulation pathway can exceed 70°C, eg it can be around 80°C.

One form of oven to which the steam treatment apparatus according to this invention is particularly applicable is, as mentioned above, bakery ovens for the production of bread and related products. Such ovens may take any one of a number of conventional forms, eg those known as deck ovens, rack ovens and travelling ovens. Typically, in such an oven the oven cavity or chamber has a volume of the order of 1m³ or more, though in some cases (for example in rack ovens), the volume can be substantially greater. Certain types of such ovens will be substantially sealed during use, although travelling ovens, in which the products to be baked are transported continuously through the oven on a conveyor system, are generally open at each end, curtains or the like generally being provided which partially or loosely close the ends of the oven cavity for virtually continuous access.

There is preferably provided a control unit by which operation of the system is controlled. Such a unit will most preferably be microprocessor-based and acts to vary the injection of water or steam into the system and the temperature within the system in response to measurements made by various sensors. Typically, the control means can function as a look-up system, setting the operating conditions in accordance with one of a number of stored data sets, each appropriate to a different type of product.

Steam treatment apparatus embodying the invention will now be described in greater detail, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic illustration of a travelling baking oven provided with the apparatus,

Figure 2 is a schematic cross-sectional view of another form of a travelling bakery oven connected to separate apparatus,

Figure 3 is a schematic sectional view of a bakery deck oven partly incorporating the apparatus.

Figure 4 is a side view of a circulation system for an oven; and

Figure 5 is an enlarged scale side view in section of a form of water nozzle for use in the apparatus.

Referring first to Figure 1, a bakery oven of the travelling type has an oven cavity or chamber (14) through which bread or other products (e.g. loaves L) are transported on a conveyor (16), in the direction of the arrow A. A steamy atmosphere is provided within the oven cavity (14) as follows:-

10 Water is fed through a suitable filter (1) to remove insoluble materials, and then through a water softening system (2) to prevent or minimise the production of limescale. The treated water is then passed through a pump (3) where the water is pressurised to up to 20 bar. This prevents the water from boiling when it is heated.

15 The pressurised water is passed through a heat exchanger (4), which recovers heat from the hot flue gases exhausted by the oven i.e. as indicated at E. As the water passes through the heat exchanger (4) it can be heated to up to 200°C. The pressurised heated water is then fed into a circulating loop (12) of a pathway arrangement (100) through an arrangement of one or more variable nozzles (6), that are controlled by a control system (15) as referred to below. This circulating loop (12) is connected to the steaming zone of the oven cavity (14) and
20 continuously circulates the steam through the oven cavity (14) as indicated by the arrows C to ensure an even distribution of the steamy atmospheric conditions therein.

The arrangement of one or more nozzles (6) emits the pressurised heated water as a mixture of fine particles of water of up to 150µm diameter and steam. This mixture is circulated

around the circulating loop (12) by means of a fan (7). If necessary an auxiliary heater (10) is employed to fully convert the mixture into steam prior to entry into the oven cavity (14).

Also incorporated into the circulating loop (12) is the control system (15), with sensors to measure temperature (8), humidity (dew point) (9) and pressure (13) and so controls the
5 steamy atmosphere in the oven cavity (14).

The control system (15) controls the operation of the variable nozzle arrangement (6) and auxiliary heater (10) in maintaining the required atmospheric conditions within the oven cavity (14).

Similarly, the control system (15) controls the pressure within the oven cavity (14) to
10 minimise losses to the external surroundings.

Figure 2 shows another form of a travelling bakery oven provided with the apparatus. This arrangement comprises an oven cavity (23) through which bread products such as loaves (L) are transported on a conveyor (22).

The oven cavity (23) is connected via an inlet or flow duct (24) and a return or exhaust duct
15 (25) to a steaming unit (26) in the pathway arrangement (100). The steaming unit (26) is supplied with water and contains components such as the nozzles, fan and an atmosphere control system similar to that described in relation to Figure 1.

Within the cavity (23) the inlet duct (24) terminates in a distribution box (27), the lower face of which is formed with a plurality of apertures (28). The apertures (28) are configured to
20 direct the steam passing through them in such a manner as to create a uniform distribution of steam within the oven cavity (23), as indicated by the broken arrows D.

Both the flow duct (24) and the return duct (25) can be of either rigid or flexible construction. Similarly, the steaming unit (26) can be integrated into the oven or can be a separate unit positioned, for example, alongside the oven as shown.

Figure 3 shows how the apparatus can be applied to a so-called deck oven (31). Such an oven comprises an oven cabinet (30) providing the cavity and having in its lower portion a burner or burners (32) for heating the cavity. A plurality of individual oven decks (33) are provided in the cavity, each of which is loaded with bread products such as loaves L. (Figure 3 showing such products only in the uppermost deck (33)).

The oven cabinet (30) incorporates an inlet or flow manifold (34) and an exhaust manifold (35) as part of the pathway arrangement (100) for steam circulation. Again, water is fed via a pre-treatment unit (42) (to filter and de-scale the water) to a pump (36) and a heat exchanger (37). The heat exchanger (37) is heated by hot exhaust gases from the oven cabinet (30), as indicated by the arrow E. The heated and pressurised water passes via a control valve (38) to one or more spray nozzles (39) by which the water is injected into a heated circulating airflow whereby steam circulation is provided. The flow of air is created by a fan (40) and the air is heated by a heater (41).

A practical arrangement of a circulation system which may be used is shown in Figure 4. This comprises a fan (51) which draws air from an inlet duct (50) and passes the air through an electric heater (52) and along a return duct (53). A water nozzle (54) is positioned to direct water mist coaxially into the return duct (53) and so provide the steam circulation.

One form of water nozzle (6 or 39) suitable for use in any of the embodiments described above is shown in Figure 5. This comprises a cylindrical chamber (60) which is closed at the right hand end, as viewed in Figure 5. A water inlet (61) is positioned generally centrally of the chamber (60) and feeds water into an annular space between seals (62,63) at opposite ends of a piston or spool valve (64) mounted on an operating rod (65) for reciprocating motion within the chamber (60).

In the position shown in Figure 5, there is no outlet for water from the nozzle. However, in the portion of the chamber (60) to the right (as viewed in Figure 5) of the seal (62), a plurality of spaced apart openings (66) are formed. If the piston or valve (64) is moved to the right then the seal (62) will progressively move axially relative to the apertures (66) so that first one and then more of the apertures (66) will lie between the two seals (62,63). The number of apertures (66) which are in fluid communication with the water inlet (61) can therefore be varied, in order to increase or decrease the flow rate of water from the nozzle. A funnel-shaped cowl (67) is mounted about the chamber (60) so that water escaping from the aperture or apertures (66) impinges at an angle of approximately 45° on the internal surface of the cowl (67) so as to be directed forwardly, the associated impact assisting in atomization of the water.

CLAIMS

1. Steam treatment apparatus for the provision of steam in the baking or cooking cavity or chamber of a baking or like oven for the steam treatment of foodstuff therein is characterised by the steam treatment apparatus providing a steam circulation pathway arrangement (100) for, or in, communication with the cavity or chamber (14, 27 or 30), of a said oven (11, 21, or 31) whereby the cavity or chamber (14, 23 or 30) forms part of the circulation pathway arrangement (100) for the circulation of steam therethrough, the apparatus further including means (4/16, 26 or 37/39) for generating steam for circulation along the pathway arrangement (100) and means (7, 26 or 40) for causing the steam to circulate along said pathway arrangement (100).
2. Steam treatment apparatus according to claim 1 wherein the means (4/6, 26 or 37/39) for generating steam for circulation along the arrangement pathway (100) is arranged to create steamy atmospheric conditions within the oven cavity or chamber (14, 23 or 30) for effective treatment of foodstuff (L) in the latter.
3. Steam treatment apparatus according to claim 1 or 2 wherein the means (26) for generating steam for circulation along the pathway arrangement (100) is situated in use externally of the oven (21) and communicates with the oven cavity or chamber (23) for circulating a supply of steam thereto.
4. Steam treatment apparatus according to claim 1, 2 or 3 wherein the means (4/6, 26, or 37/39) for generating steam for circulation along the pathway arrangement (100) is provided partly or wholly within said pathway arrangement (100).
5. Steam treatment apparatus according to any of claims 1 to 4 wherein the means (7, 40) for causing the steam to circulate along the pathway arrangement (100) is provided within it for effecting said circulation.

6. Steam treatment apparatus according to claim 1 or 5 wherein the means for causing the steam to circulate along the pathway arrangement (100) consists of a driven rotary fan (7, 40) within the pathway arrangement (100).
- 5 7. Steam treatment apparatus according to any of the preceding claims wherein the means (4/6, 26 or 37/39) for generating steam for circulation along the pathway arrangement (100) comprises or includes means (4, 37) for the preheating and/or pressurising of water and the injection (6, 39) of said preheated and/or pressurised water into the pathway arrangement (100) to provide resulting steam circulation therein.
- 10 8. Steam treatment apparatus according to claim 7 wherein the preheating of the water is of the order of 150°C to 200°C and/or pressurising of the water is of the order of 15 to 20 bar.
- 15 9. Steam treatment apparatus according to claim 7 or 8 wherein injection of the preheated and/or pressurised water into the pathway arrangement (100) is effected through one or more variable flow nozzles (6, 39).
- 20 10. Steam treatment apparatus according to any of claims 7, 8 or 9 wherein the preheated and/or pressurised water is arranged to be directed into a part of the pathway arrangement (100) having means (40, 41 or 50, 51, 52) for introducing a heated air flow therein and into which the preheated and/or pressurised water is injected (39 or 54) to provide steam for circulation along the pathway arrangement (100) and through the oven cavity or chamber (30).

11. Steam treatment apparatus according to claim 4 or any of claims 7 to 10 wherein heater or heat exchanger means (4, 37) for steam generation and/or for injection water preheating is arranged to receive exhaust flow (E) of hot flue gases and any steam from the cavity or chamber (14 or 30) of the oven (11 or 31) in order to effect, or at least assist, the heating operation of the heater or heat exchanger means (4, 37).
12. Steam treatment apparatus according to any of the preceding claims wherein the pathway arrangement (100) includes inlet and outlet manifolds (34, 35) provided, or adapted to be provided in the cavity or chamber (30) of an oven (31) (e.g. of the deck type) for steam circulation through the cavity or chamber (30).
13. Steam treatment apparatus according to any of the preceding claims wherein auxiliary heating means (10) is provided in the pathway arrangement (100).
14. Steam treatment apparatus according to any of the preceding claims wherein inlet communication of the pathway arrangement (100) with the cavity or chamber (23) of an oven includes deflectors or baffles, or at least one apertured plate or box (27) for direction and/or distribution of incoming steam in the cavity or chamber (23).
15. Steam treatment apparatus according to any of the preceding claims wherein control means (15) is provided for controlling the general operation of the apparatus and associated oven (11, 21 or 31).
16. Steam treatment apparatus according to claim 15 wherein the control means (15) controls the injection (6, or 39) of preheated and/or pressurised water into the pathway arrangement (100) and so controls flow rate of steam therein to and through the cavity or chamber (14 or 30) of an oven (11 or 31) and so maintains required steamy atmospheric conditions in said cavity or chamber (14 or 30).

17. Steam treatment apparatus according to claim 15 wherein the control means includes sensors to measure temperature, humidity (dew point) and pressure as necessary within the pathway arrangement (100) and oven (11, 21 or 31) for maintaining required operation of the apparatus and oven (11, 21, 31).
- 5 18. Steam treatment apparatus according to claim 15 wherein the control means (15) controls pressure within the cavity or chamber (14, 23 or 30) of an oven (11, 21 or 31) to minimise loss of steam and flue gases to the exterior of the oven cavity or chamber (14, 23 or 30).
- 10 19. Steam treatment apparatus according to any of claims 15 to 18 wherein the control means (15) is microprocessor based.
20. Steam treatment apparatus according to any of claims 15 to 19 wherein the control means (15) is arranged to operate as a look-up system for setting the operating conditions of the apparatus and an associated oven (11, 21 or 31) in accordance with stored data including any one of a number of stored data sets, each appropriate to
15 different operating condition requirements.
21. A bakery or like oven provided by connection thereto or by at least partial incorporation therein steam treatment apparatus according to any of the preceding claims

1/3

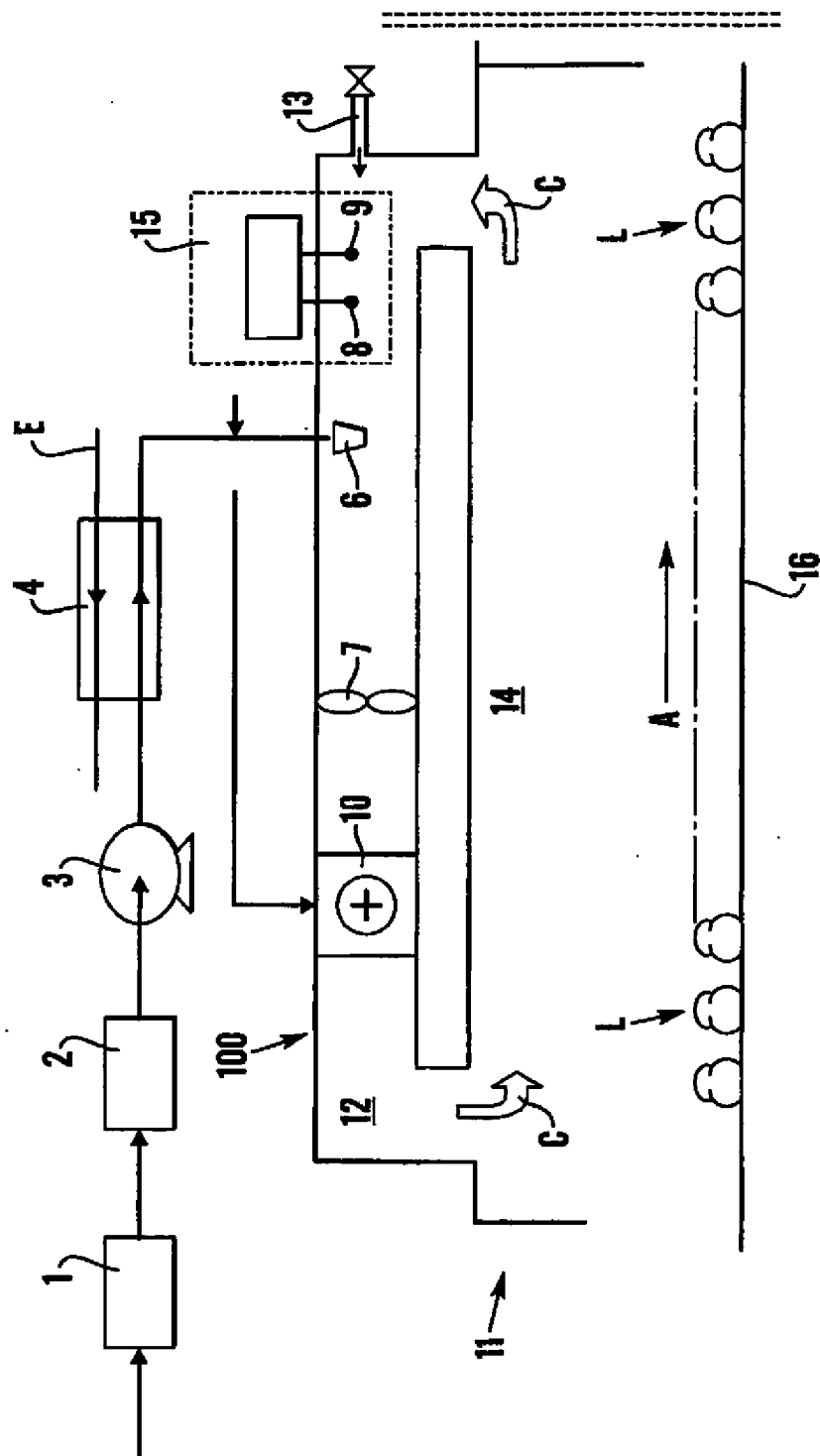


Fig. 1

2/3

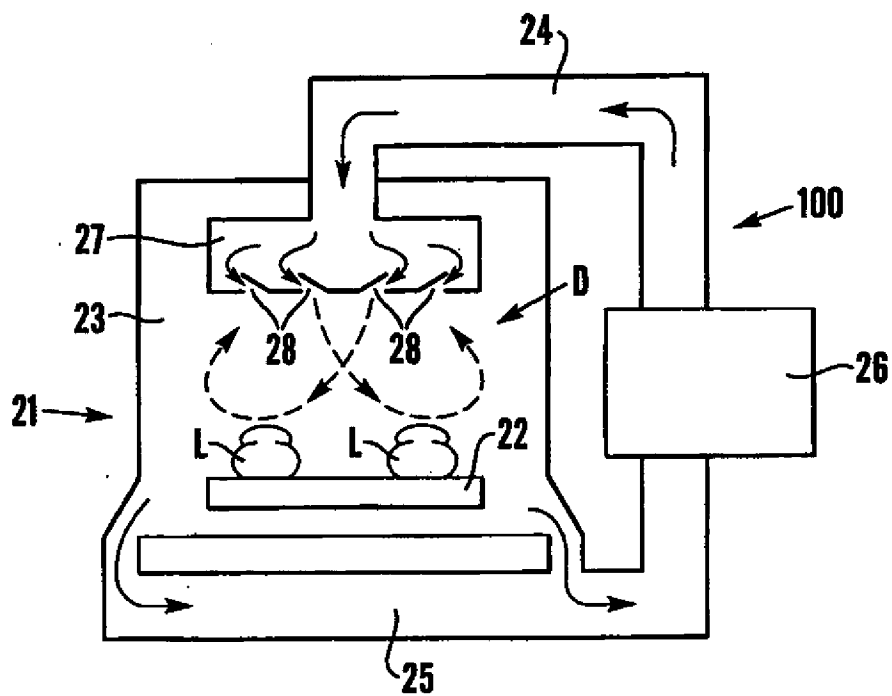


Fig. 2

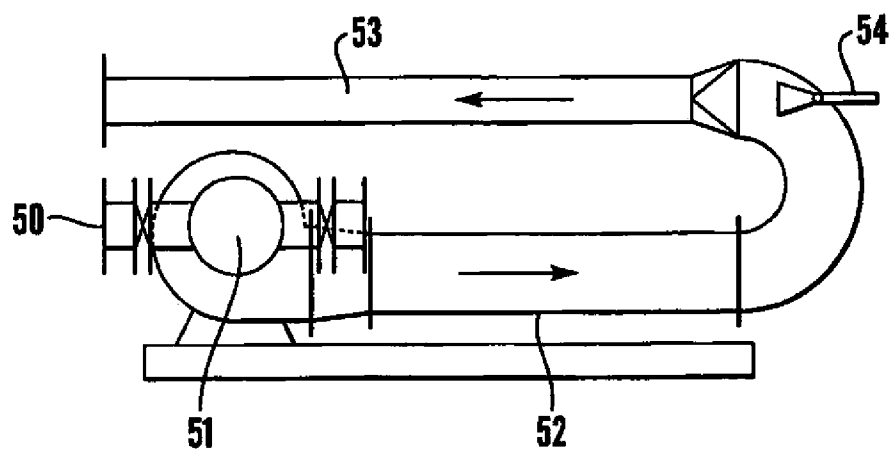


Fig. 4

3/3

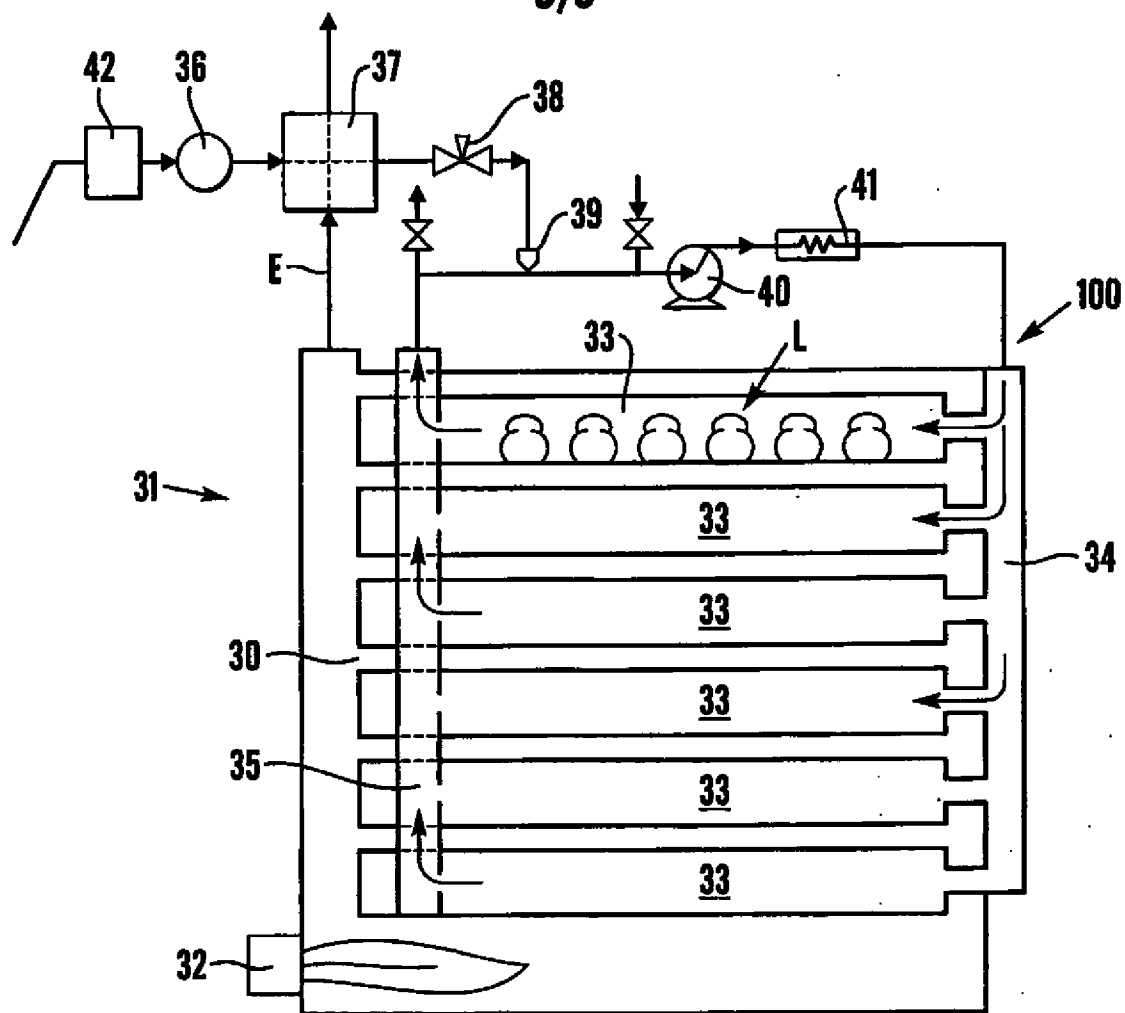


Fig.3

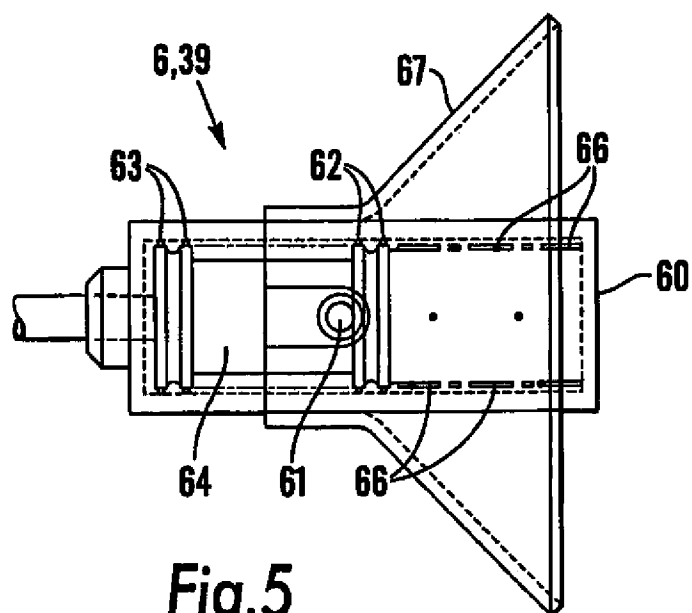


Fig.5

INTERNATIONAL SEARCH REPORT

Inventor's Application No

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F24C15/32 A21B1/24 A21B3/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F24C A21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

MARZANO MONTERO., M

INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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